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EVALUATION OF THE AN/SLR-503 AS A TUNER FOR AN INTRA-PULSE SYSTEM

by

Guy Farley
Radar Electronic Support Measures Section
Electronic Warfare Division

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ABSTRACT

This report evaluates the AN/SLR-503 with respect to its suitability as a tuner for an intrapulse system. It shows that the only reasonable way this could be done is to tap a portion of its internal 400 MHz IF signal and perform all further processing using this signal. It examines the bandwidth and the phase quality of that signal as well as the accuracy of the LO that produces it. The results of these laboratory measurements show that the AN/SLR-503 should not be used as a tuner for an intrapulse system.

RÉSUMÉ

Ce rapport évalue la possibilité d'utiliser le AN/SLR-503 comme syntonisateur d'un système "intra-pulse". On y démontre que la seule façon raisonnable d'achever cet objectif est de capter une partie du signal intermédiaire interne de 400 MHz et d'opérer tout traitement additionnel en utilisant ce signal. On y examine la largeur de bande et la qualité de la phase de ce signal ainsi que la précision de l'oscillateur local qui le produit. Les résultats de ces mesures en laboratoire démontrent que le AN/SLR-503 ne devrait pas être utilisé comme syntonisateur d'un système "intra-pulse".

EXECUTIVE SUMMARY

This report evaluates the suitability of using the AN/SLR-503 as a tuner for an intrapulse system. It provides a brief description of that system to show how it could be used in that respect. It then reports on different laboratory measurements which show why the AN/SLR-503 would not be suitable to be used as a tuner for an intrapulse system. This evaluation was important since a specific application existed where the AN/SLR-503 would have otherwise been attractive on account of its availability.

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1.0 INTRODUCTION

This report documents a laboratory evaluation of the Countermeasures Receiving Set AN/SLR-503. The purpose of the evaluation is to determine if that system could be used in an intrapulse system to down convert the RF signals to an IF frequency. The report is divided into eight sections. The first two are introductory in nature and serve to explain the rationale for considering the AN/SLR-503 as a tuner for an intrapulse system. Section 3.0 gives a brief description of the AN/SLR-503 as it relates to its intended utilization which is described in section 4.0. The following three sections document the results of the laboratory evaluation: section 5.0 presents the IF bandwidth obtained with the AN/SLR-503, section 6.0 sheds light on the phase quality of the circuits of the AN/SLR-503, and section 7.0 presents the LO stability of the AN/SLR-503. Finally, section 8.0 summarizes these results and draws conclusions.

2.0 BACKGROUND

The Canadian Navy has given DREO a task to investigate the applicability of intrapulse measures. This task stipulates that a system will be built and trialed at sea. In order to save money, it is proposed that the applicability of the WLR-1 be investigated since many Canadian vessels are still equipped with it. If acceptable, this receiver's antennae and tuners will then be used to receive and down convert the radar signals to the intermediate frequency (IF) of the intrapulse system.

For convenience, we chose to investigate in this report the applicability of the AN/SLR-503 tuner since the controller and power supply are self-contained in that system. This gives a representative evaluation of the WLR-1 tuners since that system uses the same tuner as the Band 9 tuner of the WLR-1 which is the one that covers frequencies from 7.3 to 10.75 GHz. In fact, the AN/SLR-503 was designed to augment the capability of the WLR-1 and can be used in conjunction with it as it is on certain vessels. The Band 9 of the WLR-1 is the most important for this application because most shipborne navigation radars operate in that band.

3.0 DESCRIPTION OF THE AN/SLR-503

3.1 GENERAL

The Countermeasures Receiving Set AN/SLR-503 is a superheterodyne receiving set which covers the frequency range between 7.3 and 10.75 GHz [1]. The equipment can be installed on board any submarine, surface ship or shore installation which has 115

Vac, 60 Hz primary power. The AN/SLR-503 can also be used in conjunction with the AN/WLR-1G or AN/WLR1C as a Band 9 alarm system with video presentations on the IP-480. The system is comprised of two separate units as shown in figure 1. Each unit is

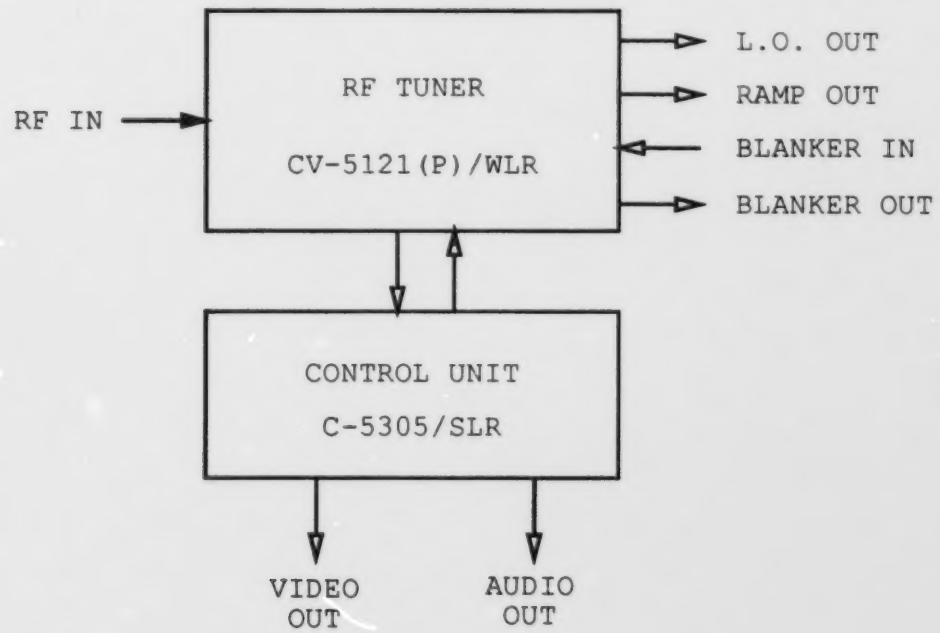

Figure 1: AN/SLR-503 Block Diagram

further described in the following subsections.

3.2 RF TUNER

RF signals in the frequency range of the AN/SLR-503 are received from either an omnidirectional or directional antenna and processed through the RF Tuner CV-5121(P)/WLR. The AN/SLR-503 can be operated in either of the two modes: scan or analysis. In frequency scan operation, the full range of the Tuner is covered in 2.4 seconds. However, the entire frequency range need not be scanned. If only a particular segment of the frequency band is of interest, the servo controlled sweep range can be adjusted, thereby giving a higher probability of intercept. Any received signal can be monitored or detail analysis performed by placing the Tuner in manual position and tuning to the frequency of interest. In manual operation, a tuning knob, in conjunction with a servo system, controls the frequency of the RF Tuner and the frequency of an intercepted signal is presented by a digital display. The RF Tuner receives, amplifies and converts the RF signals to an IF

signal. This IF signal is further processed to produce video for visual presentation and audio for presentation at audio connectors.

Figure 2 shows a functional block diagram of the RF Tuner. Referring to this

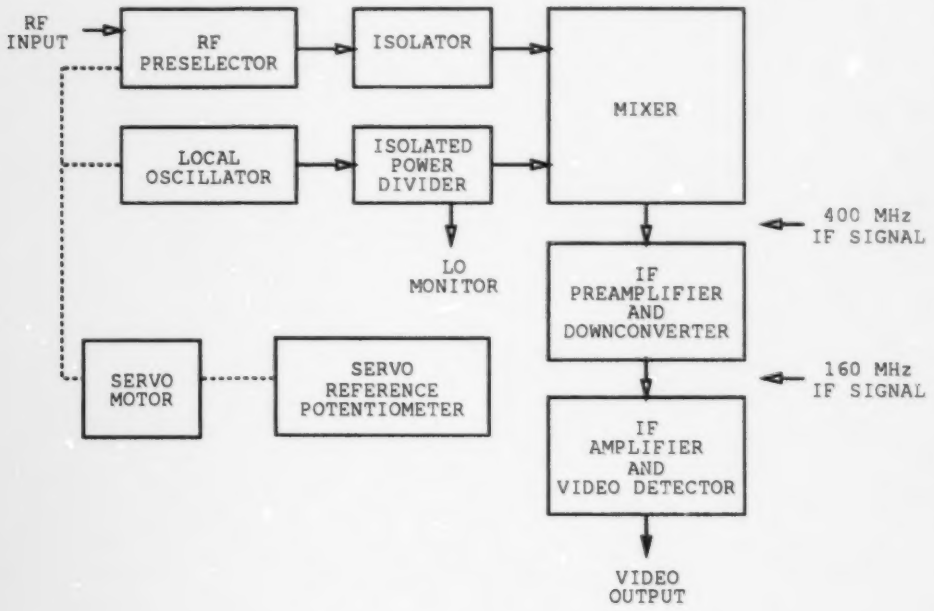

Figure 2: CV-5121(P)/WLR RF Tuner Functional Block Diagram

figure, we note that RF energy from the antenna is fed through the RF preselector to the balanced mixer where it is mixed with the signal from the local oscillator (LO) to produce a 400 MHz IF signal. The 400 MHz IF signal is amplified by the amplifier which is contained in the mixer and applied to the IF preamplifier where it is further amplified and mixed with a 240 MHz signal from a second local oscillator (not shown) to produce a 160 MHZ second IF signal. The IF Amplifier accepts a 160 MHz signal from the IF Preamplifier, amplifies, detects and provides a 4 volt positive video pulse output to the control unit to drive a pulse analyzer or an oscilloscope display. Either manual gain or automatic gain control (AGC) operation of the IF Amplifier can be selected via an operator controlled switch on the control unit. When the IF Amplifier is removed, the CV-5121(P)/WLR can be directly interfaced into Band 9 position of the AN/WLR-1.

It should be noted that the servo motor is mechanically linked to the RF Preselector, the first LO and the Servo Reference Potentiometer. It is the latter which provides positional information to the servo motor. It is important that the RF preselector be linked with the LO since it is a tuned bandpass filter. The IF Preamplifier also performs

bandpass filtering with the result that its output IF signal has a bandwidth restricted to 20 MHz about the 160 MHz carrier.

3.3 CONTROL UNIT

The Control Unit C-5305/SLR contains all operator controls, a regulated power supply, servo amplifier, video and audio gain controls, a video pulse stretcher, and provides power distribution to the Tuner. All controls and indicators for operation of the AN/SLR-503 receiver are in the Control Unit.

The Control Unit accepts a video pulse from the IF Amplifier of the RF Tuner and provides a gain control over its own video output. A pulse stretcher circuit is included to provide an audible signal from the narrow video pulses fed to the Control Unit. The audio signal is available at the front panel of the Control Unit along with its level control. The Servo Amplifier in conjunction with a power amplifier provides both manual tuning and automatic scanning of the Tuner and a digital panel meter indicates the Tuner frequency setting.

4.0 INTENDED UTILIZATION OF THE AN/SLR-503

The purpose of this report is to consider the utilization of the AN/SLR-503 as a tuner for an intrapulse system. The latter system measures parameters related to the amplitude and phase variations within a radar pulse. The AN/SLR-503 provides a video output signal with a 20 MHz bandwidth. This is clearly unacceptable because all phase information is lost. However, this system provides an internal 400 MHz IF signal. This means that a possible utilization of this system would be to tap a portion of the 400 MHz IF signal as shown in figure 3 where the modifications to the AN/SLR-503 are shown as dotted lines. This utilization has the advantage that the AN/SLR-503 is still operational and can be used to scan the environment. Once a signal of interest has been detected and further processing is desired with the intrapulse system, the AN/SLR-503 can be manually tuned to the proper frequency.

The following three sections examine different aspects of the quality of the 400 MHz IF signal. This examination is based on laboratory measurements performed on an AN/SLR-503 (With Tuner Serial No. 75-028) lent to DREO for the purpose of the evaluation. Although exact specifications depend on the application, it is generally considered desirable that the IF signal provided to an intrapulse system has a RF bandwidth of at least 40 MHz (up to 200 MHz for short pulses) and a phase quality allowing an instantaneous frequency measurement accurate to $\pm$ 100 kHz. Usually, a bandwidth

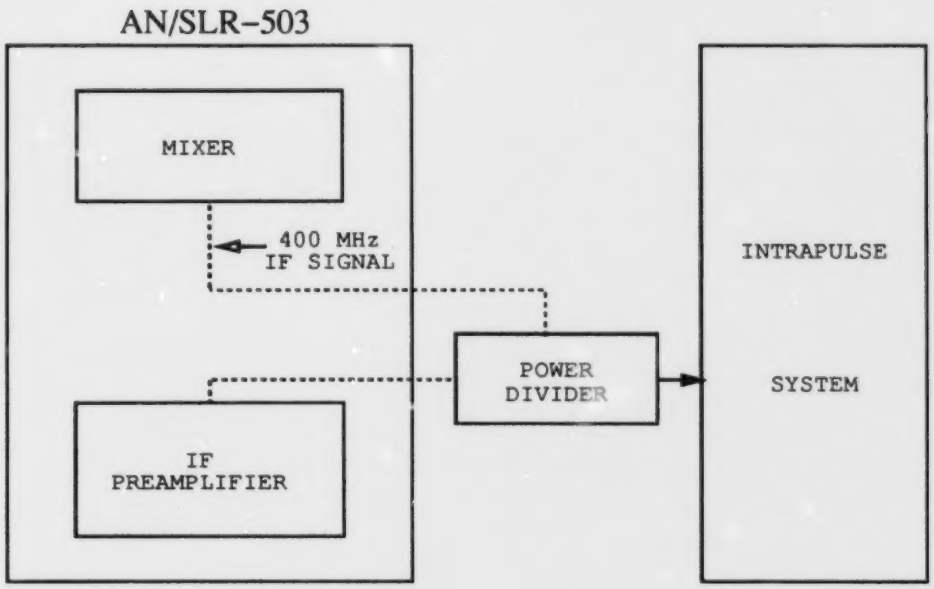

Figure 3: Block Diagram of AN/SLR-503 as Tuner for an Intrapulse System

of 100 MHz is adequate for most applications and this is the bandwidth used to make all the measurements contained in this report.

5.0 IF BANDWIDTH

The bandwidth of the IF signal provided to an intrapulse system is an important parameter. On the one hand it determines the signal to noise ratio, and on the other the distortion of the phase information of a signal. The required bandwidth is dependent on the application. For analyzing radar signals a bandwidth of at least 40 MHz is desirable for pulses on the order of 200 ns and 200 MHz for the ones on the order of 40 ns.

The setup that was used for measuring the bandwidth of the 400 MHz IF signal at the output of the first mixer of the AN/SLR-503 is shown in figure 4. We first set the Sweep Oscillator to sweep a span of 300 MHz as shown in figure 5. This figure is a copy of a spectrum analyzer trace when the resolution bandwidth is set to 300 kHz. We then measured the bandwidth of the 400 MHz IF signal while the RF input was swept at different center frequencies. Figures 6 to 10 are spectrum analyzer traces of the 400 MHz IF signal bandwidth when the digital display of the AN/SLR-503 is set to 8.0, 8.5, 9.0, 9.4, and 10.0 GHz respectively. It should be noted that those numbers do not necessarily correspond to the center frequencies of the sweep oscillator because the LO

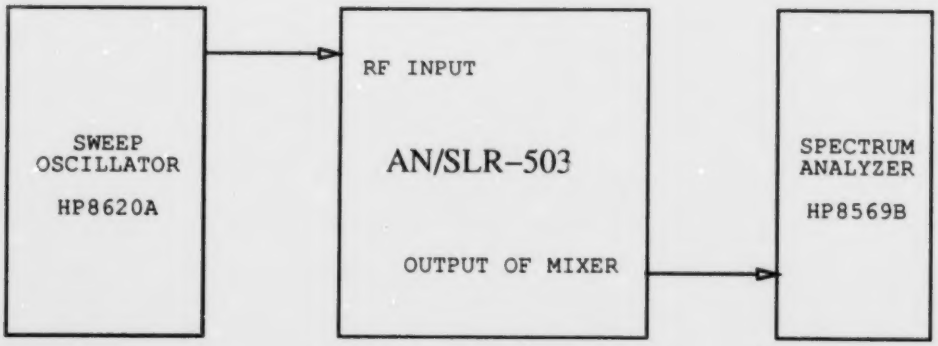

Figure 4: Setup for Bandwidth Measurement of 400 MHz IF Signal

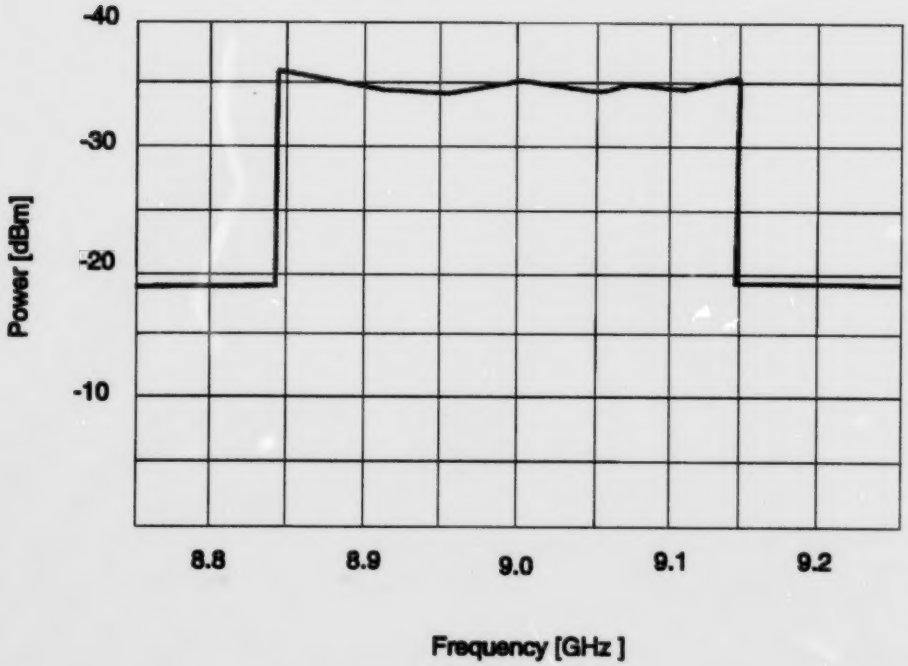

Figure 5: Output of Sweep Oscillator at 9.0 GHz

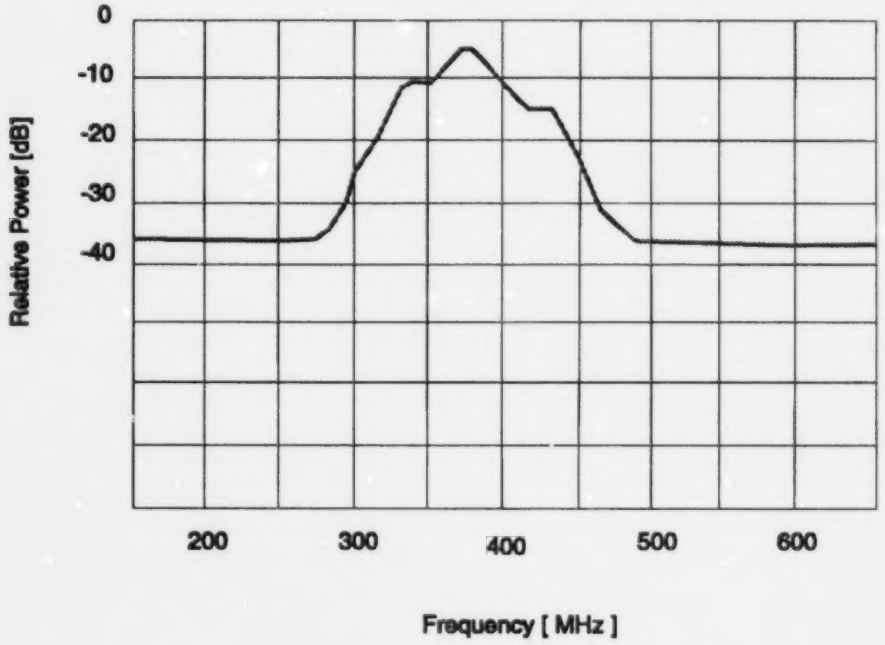

Figure 6: Bandwidth of 400 MHz IF Signal at 8.0 GHz

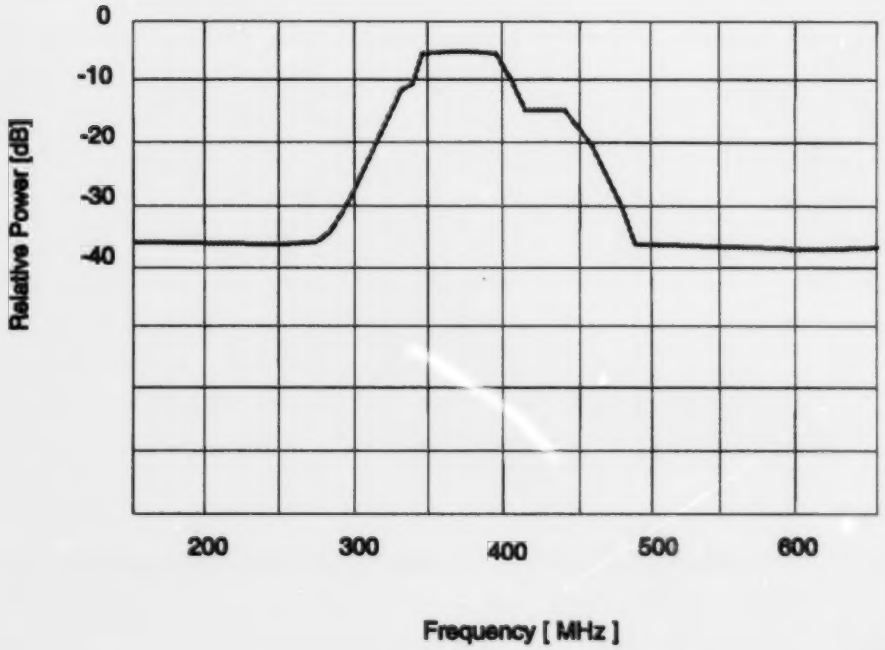

Figure 7: Bandwidth of 400 MHz IF Signal at 8.5 GHz

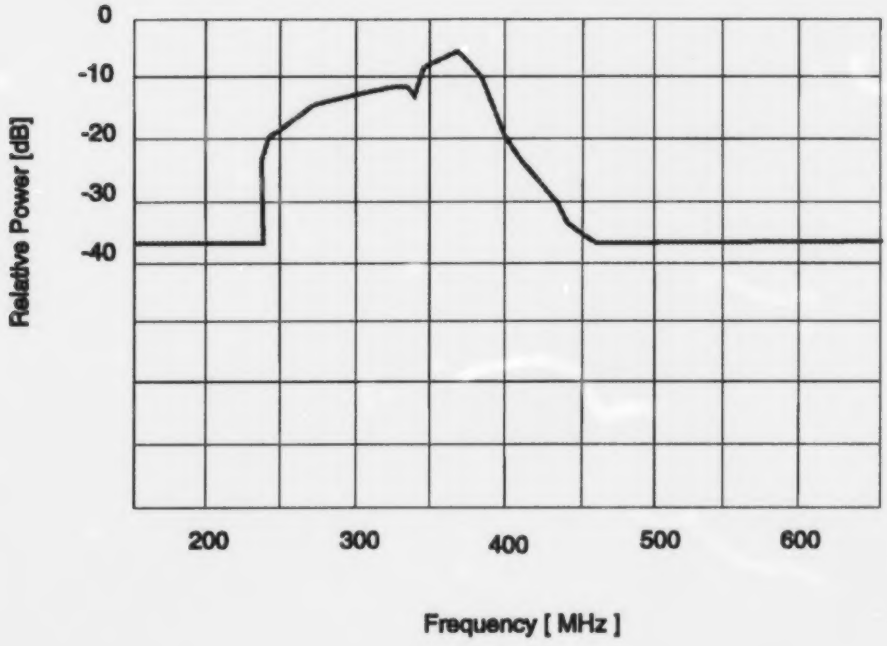

Figure 8: Bandwidth of 400 MHz IF Signal at 9.0 GHz

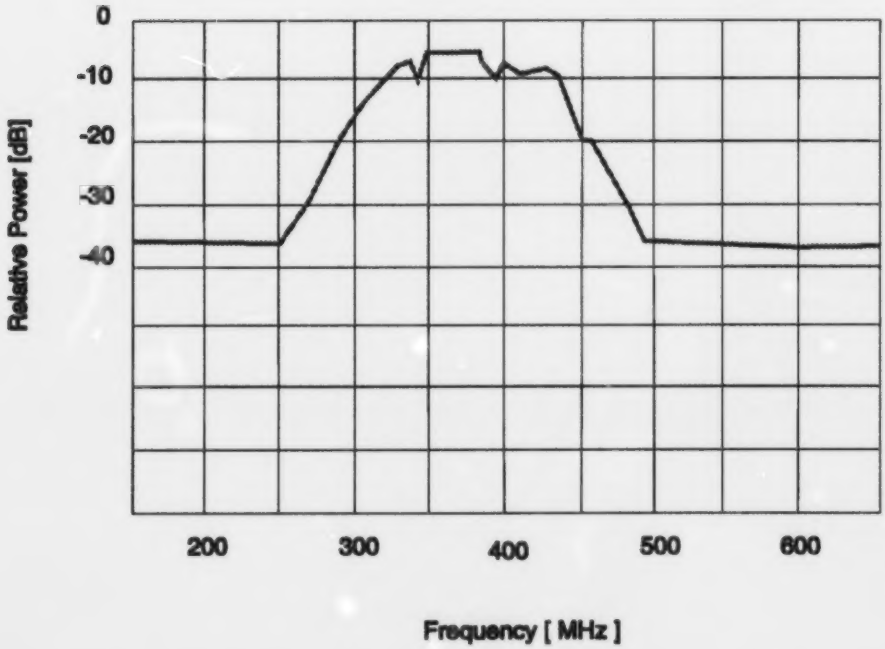

Figure 9: Bandwidth of 400 MHz IF Signal at 9.4 GHz

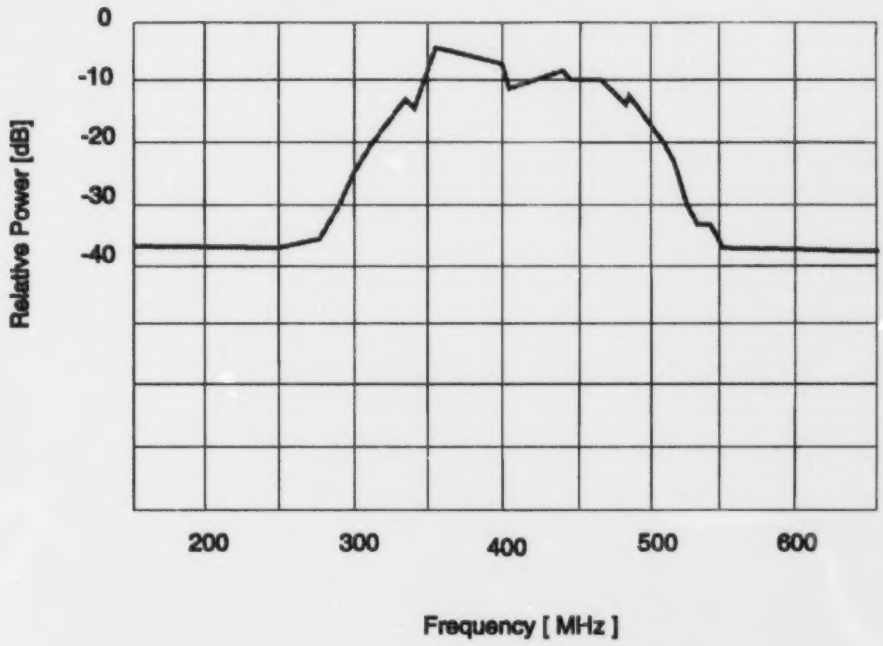

Figure 10: Bandwidth of 400 MHz IF Signal at 10.0 GHz

and the digital display of the AN/SLR-503 are not perfectly tuned. Rather, we adjusted the sweep oscillator center frequency in each case such that it down converted to 400 MHz. Hence, figures 6 to 10 represent the IF bandwidths centered on 400 MHz when the digital meter of the AN/SLR-503 is set at those different frequencies.

We can see from these figures that the 400 MHz IF signal bandwidth varies from one RF frequency to the other and that it is not always symmetrical with respect to the 400 MHz IF. The frequency response is not very flat with figure 8 showing an exceptionally bad example where a band pass of 100 MHz with respect to the 400 MHz IF experiences an amplitude variation on the order of 30 dB. It is suspected that this particular case is due to a mismatch of the RF preselector.

6.0 PHASE AND GROUP DELAY QUALITY

Since intrapulse systems measure parameters related to the phase of a signal, it is important to evaluate how each of its sub-systems affects the phase of the radar signals that it strives to analyze. Useful factors to consider in this respect are the phase and group delay quantities of the forward transmission coefficient of two-port networks which are readily measured using a phase network analyzer such as the HP8510. However, in the case of a

tuner it is impossible to obtain absolute measurements for this parameter without introducing additional components. This is due to the fact that the input signals experience frequency translation. This creates a problem in this case because the phase distortion contributions introduced by those components cannot be removed from the measurements as they often can in other metrology problems. For this reason we devised a method to measure this parameter in the case of the AN/SLR-503 tuner.

The method that we devised involves a comparison of phase measurements on the AN/SLR-503 with those obtained with two mixers. It is assumed that the measurements obtained with the two mixers are well behaved in order to provide a basis for comparison with the measurements obtained with the AN/SLR-503. This is expected because the mixer is a much simpler device with fewer sources of error within itself than the AN/SLR-503.

The block diagram for the setup used to make phase measurements with two mixers is shown in figure 11. The signal from the network analyzer is mixed to a lower fre-

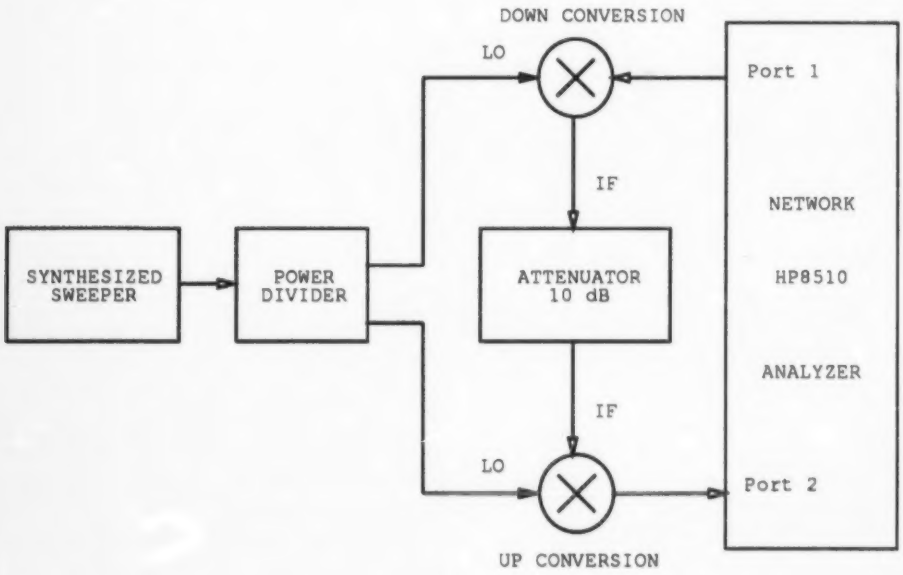

Figure 11: Block Diagram Of Phase Measurement Setup With Two Mixers

quency (400 MHz) and then back to the original value, after which the phase is measured. The mixers used were two Watkins-Johnson M77C types. To obtain phase measurements with the AN/SLR-503, we simply substituted one mixer for that system as shown in figure 12. We can see from this figure that everything else remains unchanged except for the substitution of the AN/SLR-503 for a mixer. If the measurements obtained with the

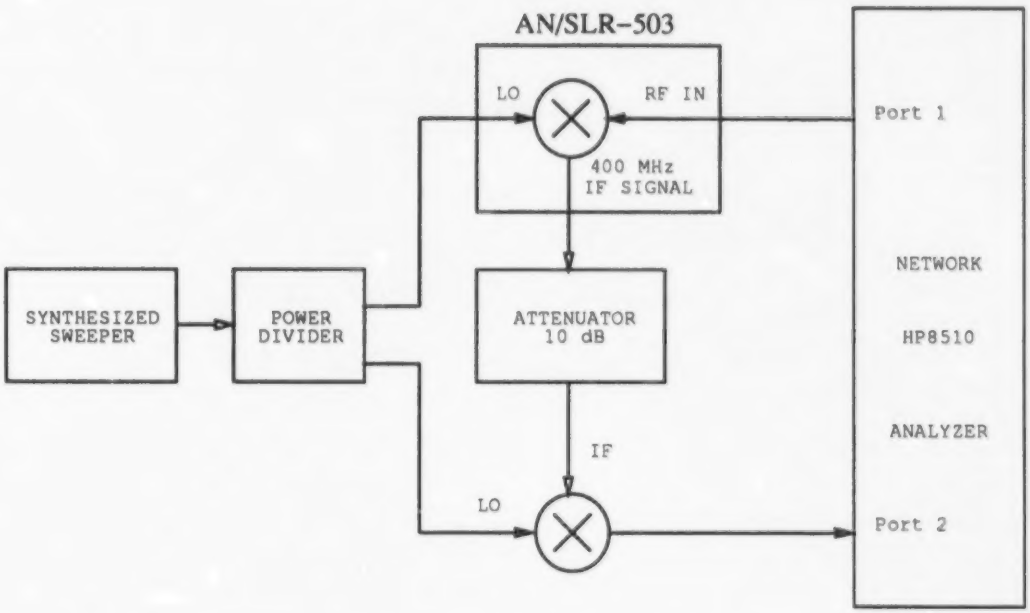

Figure 12: Block Diagram Of Phase Measurement Setup With AN/SLR-503

AN/SLR-503 turn out to be much worse than those obtained with the two mixers, we will know that the AN/SLR-503 is responsible for most of that phase corruption. Although this will not provide us with absolute phase measurements of the AN/SLR-503, it will provide some information on the phase distortion introduced by this system.

6.1 PHASE

We performed measurements using the setups of figures 11 and 12 using three different LO frequencies: 8.9, 9.8, and 10.4 GHz. In each case, we swept a bandwidth of 100 MHz and measured the phase quantity of the S_{21} parameter which is the forward transmission coefficient of the two-port network. Figure 13 shows the phase quantity of the S_{21} parameter when the setup of figure 11 was used and the LO was set to 8.9 GHz whereas figure 14 shows the same quantity under the same conditions but this time using the setup of figure 12. Similarly, figures 15 and 16 show the same quantity when the LO is set to 9.8 GHz for the two respective cases first when the two mixers are used and second when the AN/SLR-503 is used. Finally, for the LO set to 10.4 GHz figure 17 shows that phase quantity when two mixers are used whereas figure 18 shows this when the AN/SLR-503 is used. It should be noted that for figures 14, 16, and 18 the AN/SLR-503 was manually tuned such that the digital display read 8.5, 9.4, and 10.0 GHz respectively.

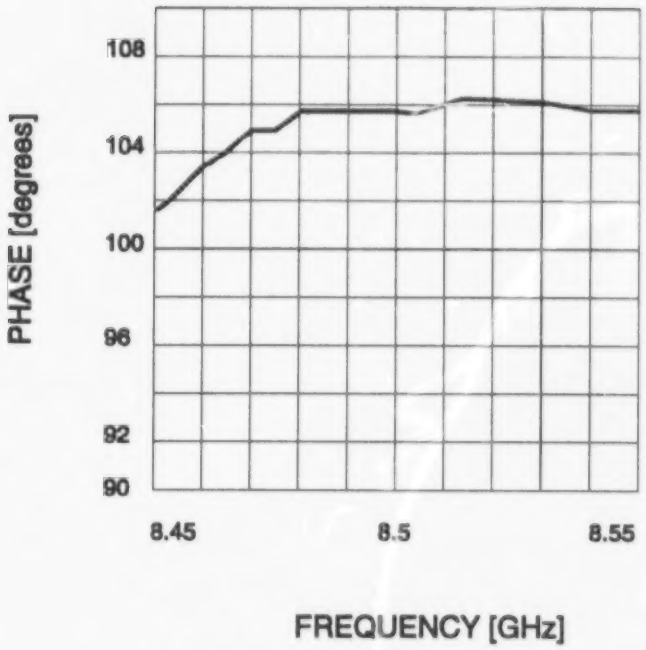

Figure 13: Phase Measurement With Two Mixers (LO = 8.9 GHz)

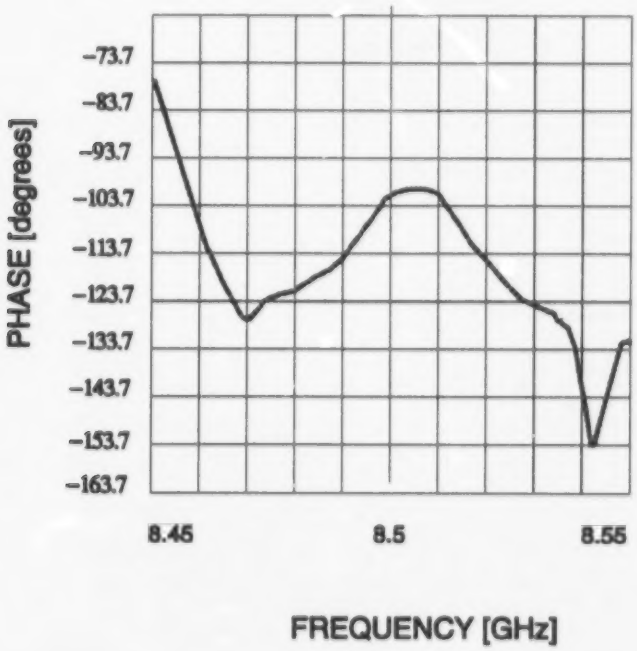

Figure 14: Phase Measurement With AN/SLR-503 (LO = 8.9 GHz)

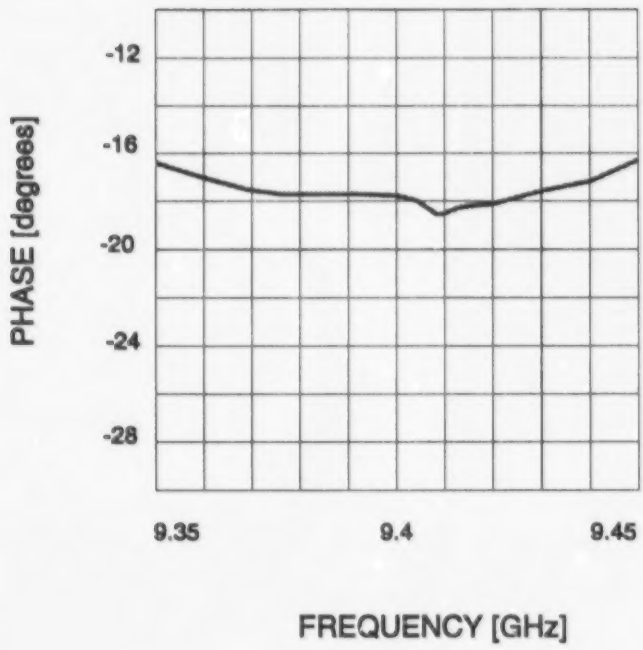

Figure 15: Phase Measurement With Two Mixers (LO = 9.8 GHz)

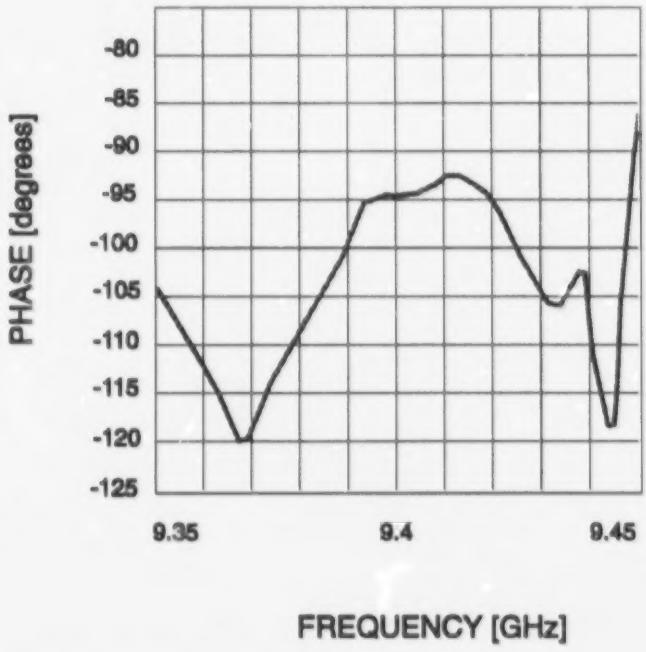

Figure 16: Phase Measurement With AN/SLR-503 (LO = 9.8 GHz)

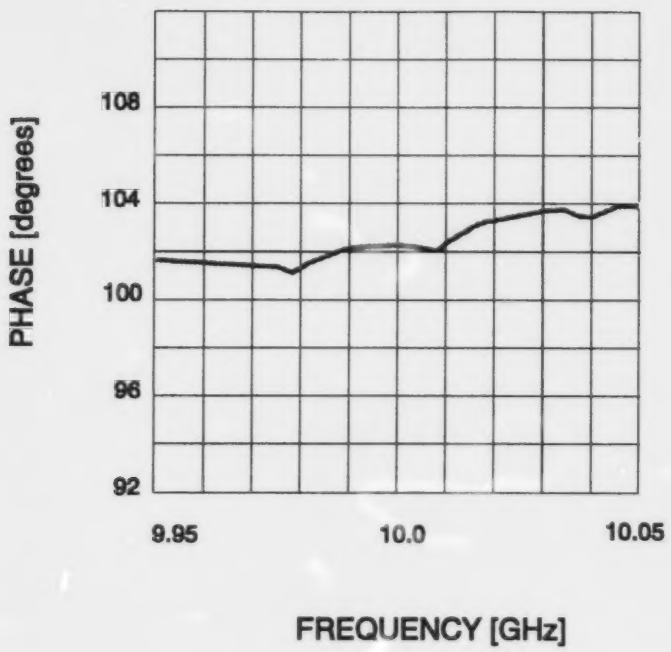

Figure 17: Phase Measurement With Two Mixers (LO = 10.4 GHz)

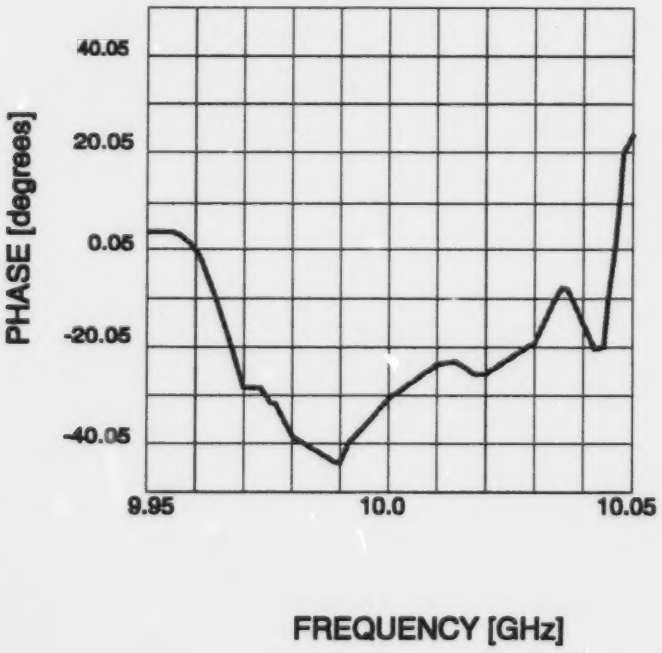

Figure 18: Phase Measurement With AN/SLR-503 (LO = 10.4 GHz)

If everything was perfect and no phase distortion was introduced, all the above figures of the phase quantity would be straight lines. From these figures, we first note that the measurements performed using the two mixers are rather smooth whereas those using the AN/SLR-503 exhibit substantial variations over a 100 MHz bandwidth. The situation is even worse when one considers the peak-to-peak variation of the phase exhibited by those figures as shown in table 1.

Table 1: Peak-to-peak variation exhibited in phase measurements.

LO (GHz)	Using two mixers	Using the AN/SLR-503
8.9	4°	70°
9.8	3°	35°
10.4	3°	35°

6.2 GROUP DELAY

It is often useful to consider the group delay which is the derivative of the phase with respect to frequency. The variation in the group delay with frequency is a measure of phase distortion.

Using the same setups and conditions as for the phase measurements, we performed measurements of the group delay using two mixers and using the AN/SLR-503. Figures 19, 21, and 23 show the group delay measurements using the setup with the two mixers when the LO is set to 8.9, 9.8, and 10.4 GHz respectively. Figures 20, 22, and 24 show the group delay measurements with the AN/SLR-503 when the LO is set to 8.9, 9.8, and 10.4 GHz respectively. It should be noted that for those last three figures the AN/SLR-503 is manually tuned such that the digital display reads 8.5, 9.4, and 10.0 GHz respectively.

For comparison purposes we have used the same vertical scale for all the figures representing the group delay measurements. An examination of those figures makes it clear that the measurements performed with the AN/SLR-503 indicate significant phase distortion. The group delay measurements obtained with the two mixers exhibit variations less than 5 nsec. whereas those for the AN/SLR-503 exhibit variations as high as 30 nsec. If we say that 5 nsec. group delay variation is due to the measurement circuitry then we are left with a 25 nsec. (30-5) variation for the AN/SLR-503. This is a peak-to-peak variation, hence assuming symmetry with respect to the perfect group delay value gives

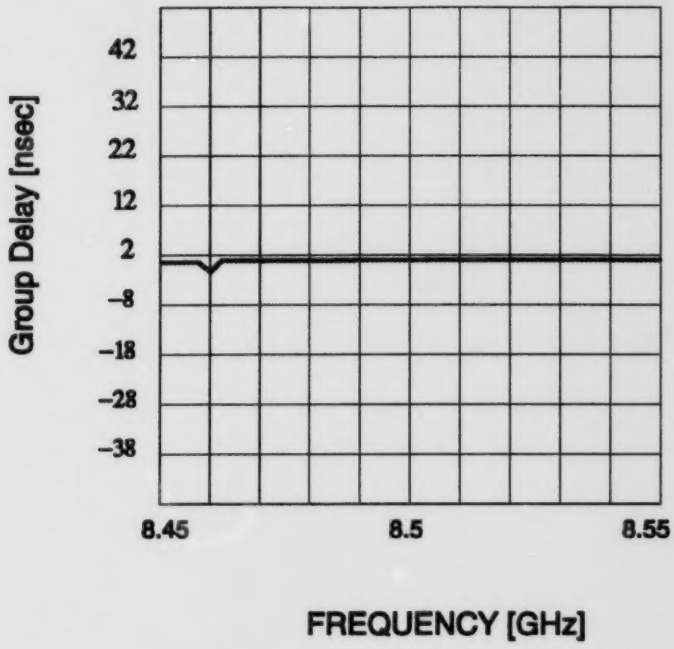

Figure 19: Group Delay Measurement With Two Mixers (LO = 8.9 GHz)

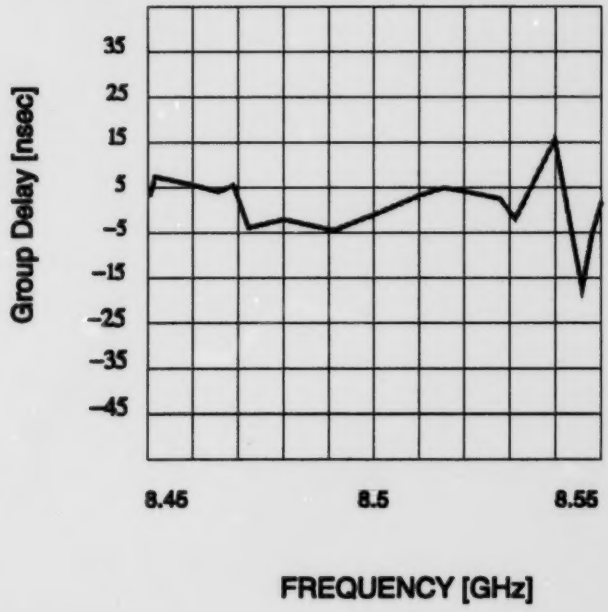

Figure 20: Group Delay Measurement With AN/SLR-503 (LO = 8.9 GHz)

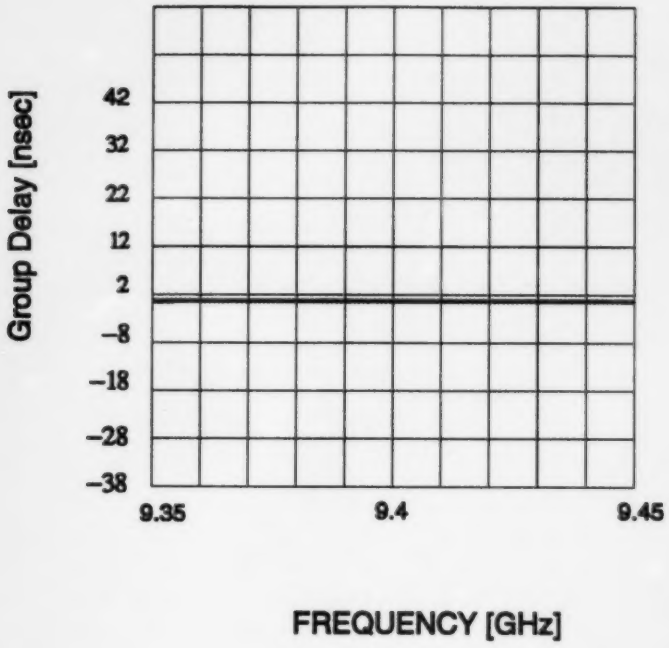

Figure 21: Group Delay Measurement With Two Mixers (LO = 9.8 GHz)

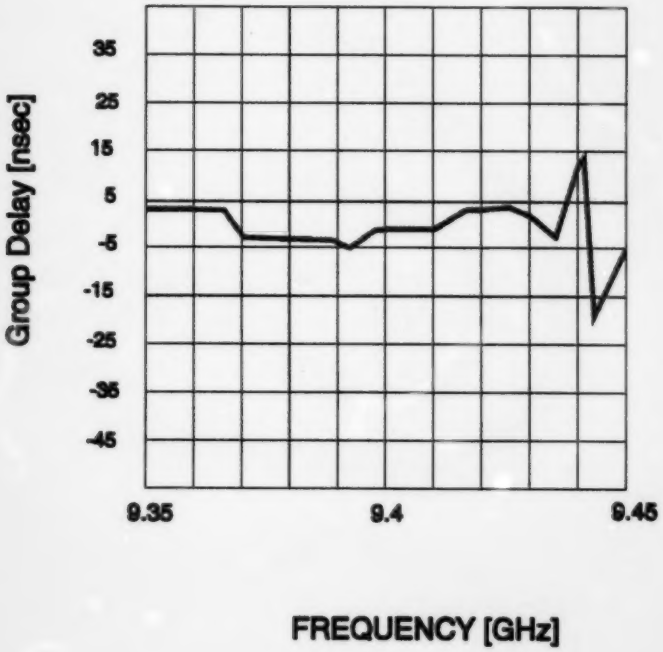

Figure 22: Group Delay Measurement With AN/SLR-503 (LO = 9.8 GHz)

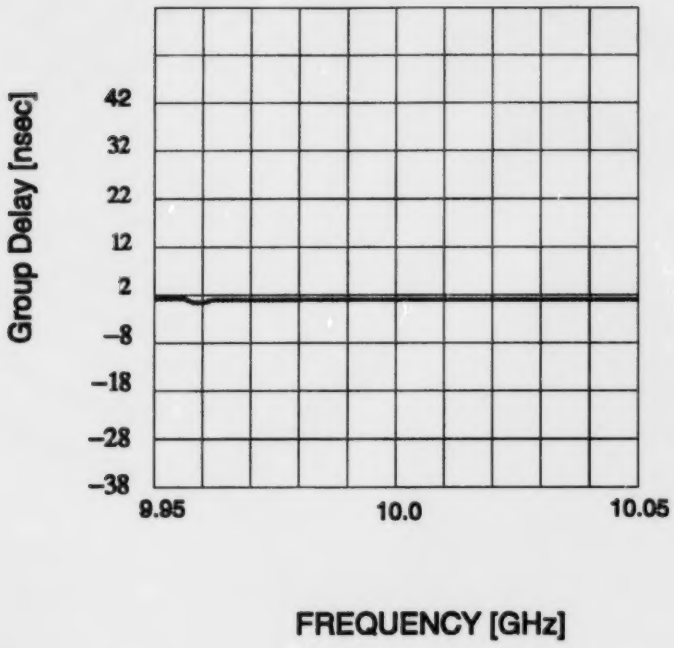

Figure 23: Group Delay Measurement With Two Mixers (LO = 10.4 GHz)

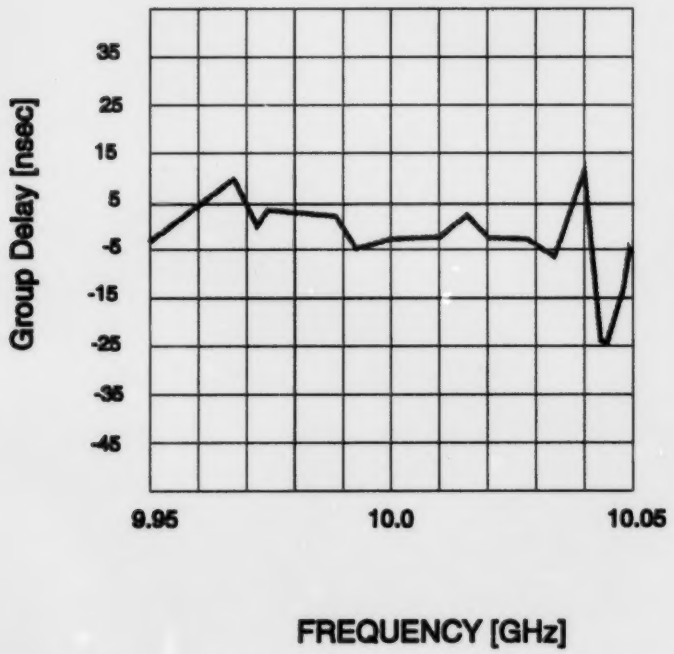

Figure 24: Group Delay Measurement With AN/SLR-503 (LO = 10.4 GHz)

a group delay variation of at least 12.5 nsec for the AN/SLR-503 at certain frequencies within a 100 MHz bandwidth.

To see how the group delay variation relates to the error in the instantaneous frequency measurement, recall that the group delay is defined as

$$\tau_g(f) = \frac{d\phi}{df} \tag{1}$$

where ϕ is phase and f is frequency. A perfect device which does not corrupt the phase has a constant $\tau_g(f)$ for all frequencies. An imperfect device which does not have a constant $\tau_g(f)$ is said to be dispersive because it distorts nonstationary signals. By considering the rate of frequency change df/dt of a nonstationary signal at a particular frequency f, we can consider an intuitive approach that relates the error in the instantaneous frequency measurement Δf after going through a device which does not have a constant group delay. For instance, a signal which exhibits a rate of frequency change df^1/dt at a particular frequency f_1 would experience a distortion of its instantaneous frequency of

$$\Delta f = \Delta\tau_g^1 \times \frac{df^1}{dt} \tag{2}$$

from going through a device which exhibits variation of its group delay of $\Delta\tau_g^1$ at frequency f_1.

Consequently, for a signal whose frequency changes by 2.4 MHz over 0.1 μsec., a 12.5 nsec. group delay variation which is exceeded by the AN/SLR-503 at certain frequencies would introduce a 300 kHz error in the measurement of the instantaneous frequency.

7.0 FREQUENCY CONVERTER ACCURACY

The previous section has shed some light on the phase corruption that the AN/SLR-503 inflicts on its input signals. However, the measurements performed do not incorporate the effect of the LO because they were all performed using a very stable high quality synthesized sweeper. The quality of the LO is very important because it has a direct influence on the accuracy and repeatability of the frequency measurements. To this end, we consider in this section both the accuracy and the stability of the LO in the AN/SLR-503. We performed this analysis using two different setups, one with a frequency counter and the other with a spectrum analyzer in each case taping into the LO monitor signal which is available as shown in figure 2.

7.1 FREQUENCY COUNTER

The first setup that we used is shown in figure 25. The frequency counter that we used

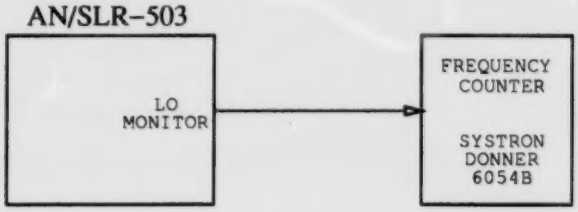

Figure 25: Frequency Converter Accuracy Measurement Setup

allowed us to measure the accuracy of the digital readout display as well as the stability of the LO. Since the frequency counter display was changing in accordance to the instability of the LO, we recorded the minimum and maximum values. The compilation of the measurements performed is shown in table 2 for the case where the tuning knob of the AN/SLR-503 was set with a clockwise motion. Table 3 shows the same for the case where the tuning knob of the AN/SLR-503 was set with a counterclockwise motion.

Table 2: Frequency counter measurements when knob tuned clockwise.

AN/SLR-503 Display (GHz)	Frequency Counter		
	Minimum (GHz)	Maximum (GHz)	Difference (kHz)
7.75	7.9679	7.9680	100
8.00	8.2194	8.2202	800
8.25	8.4820	8.4823	300
8.50	8.7698	8.7700	200
8.75	9.0507	9.0516	900
9.00	9.3301	9.3311	1000
9.25	9.6055	9.6065	1000
9.50	9.8764	9.8773	900
9.75	10.1605	10.1614	900
10.0	10.4492	10.4494	200
10.25	10.7161	10.7166	500
10.50	11.0385	11.0392	700

It should be noted that the LO frequency should ideally be 400 MHz higher than the display value because it is used to obtain a 400 MHz IF signal. It can be seen from

Table 3: Frequency counter measurements when knob tuned counterclockwise.

AN/SLR-503 Display (GHz)	Frequency Counter		
	Minimum (GHz)	Maximum (GHz)	Difference (kHz)
10.50	10.9936	10.9945	900
10.25	10.7083	10.7090	700
10.00	10.4241	10.4249	800
9.75	10.1518	10.1522	400
9.50	9.8610	9.8613	300
9.25	9.5854	9.5861	700
9.00	9.3165	9.3172	700
8.75	9.0402	9.0404	200
8.50	8.7639	8.7643	400
8.25	8.4749	8.4753	400
8.00	8.2000	8.2004	400
7.75	7.9290	7.9294	400

table 2 and 3 that the AN/SLR-503 display inaccuracy is as high as 220 MHz in certain cases. This error varies monotonically with the smallest errors occurring between 9.0 and 10.0 GHz. This inaccuracy is an indication of the mistuning between the display and the servo motor and could perhaps be corrected by proper maintenance. However, we also note from those tables that the tuning knob sensitivity varies between 1 and 5 MHz. This is indicated by the variation in the measured frequency even though the display shows the same value and is seen by a comparison of table 2 and 3.

Most importantly, it can be seen from those tables that the instability of the LO varies between 100 and 1000 kHz. This is especially important because this cannot be corrected by proper maintenance and is not repeatable.

7.2 SPECTRUM ANALYZER

We also considered the stability of the LO by using a spectrum analyzer with the setup of figure 26. Since the LO is quite unstable, we used the "max hold" setting on the display of the spectrum analyzer and obtained an instability spectrum over a 30 sec. dwell. It should be noted that the resolution bandwidth of the spectrum analyzer was set at 3 kHz.

Figures 27, 28, 29, 30, and 31 show the LO drift over a 30 sec. dwell when the AN/SLR-503 was manually tuned such that its digital display read 8.0, 8.5, 9.0, 9.4, and 10.0 GHz respectively. Although this does not give measurements as accurate as with

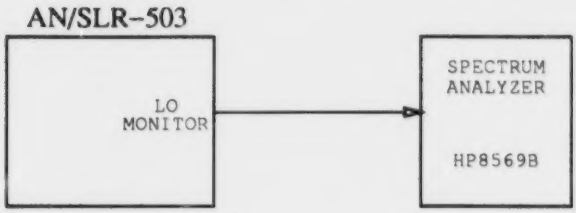

Figure 26: LO Stability Measurement Setup with Spectrum Analyzer

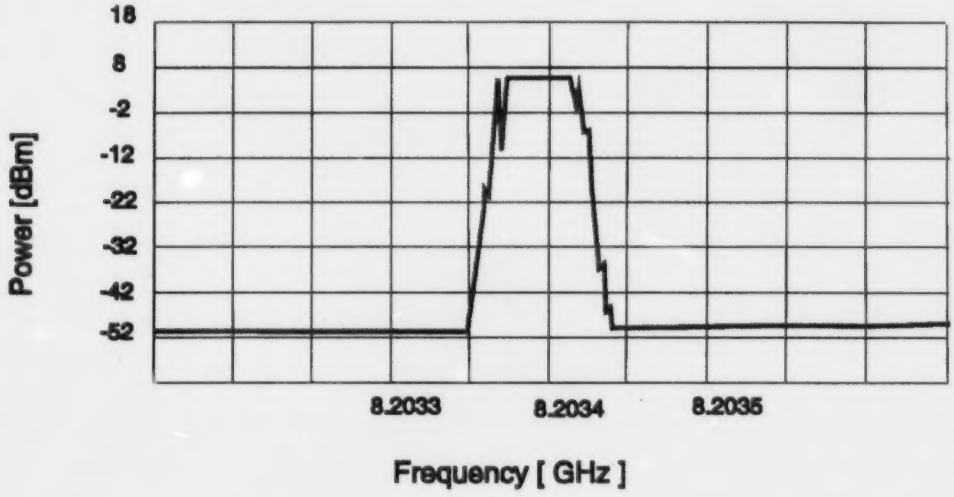

Figure 27: LO 30 sec. Drift when AN/SLR-503 set at 8.0 GHz

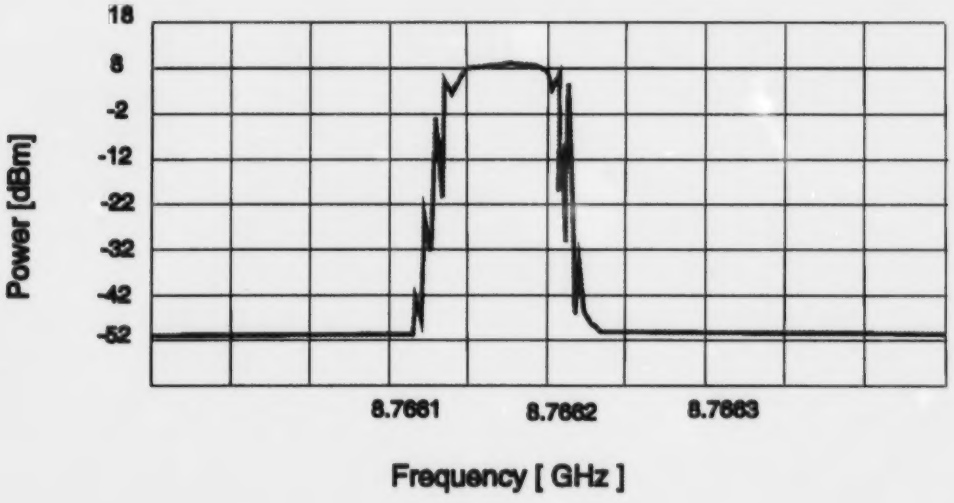

Figure 28: LO 30 sec. Drift when AN/SLR-503 set at 8.5 GHz

Figure 29: LO 30 sec. Drift when AN/SLR-503 set at 9.0 GHz

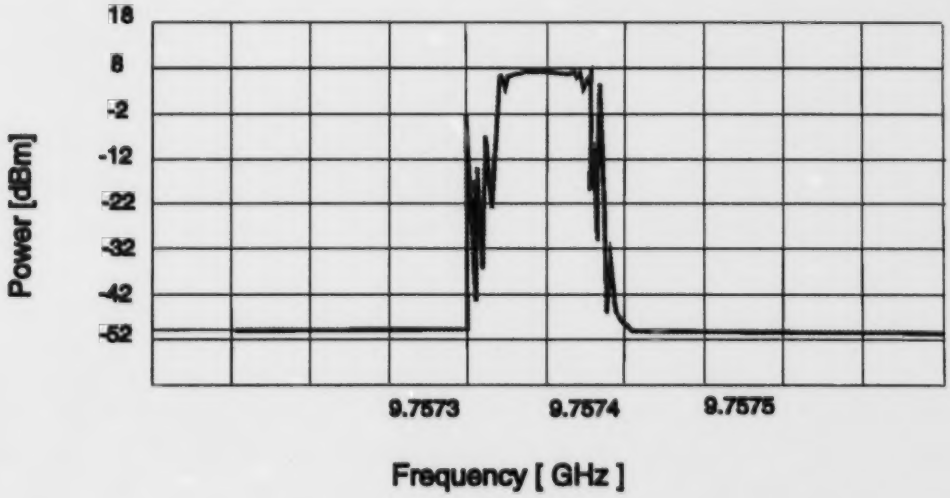

Figure 30: LO 30 sec. Drift when AN/SLR-503 set at 9.4 GHz

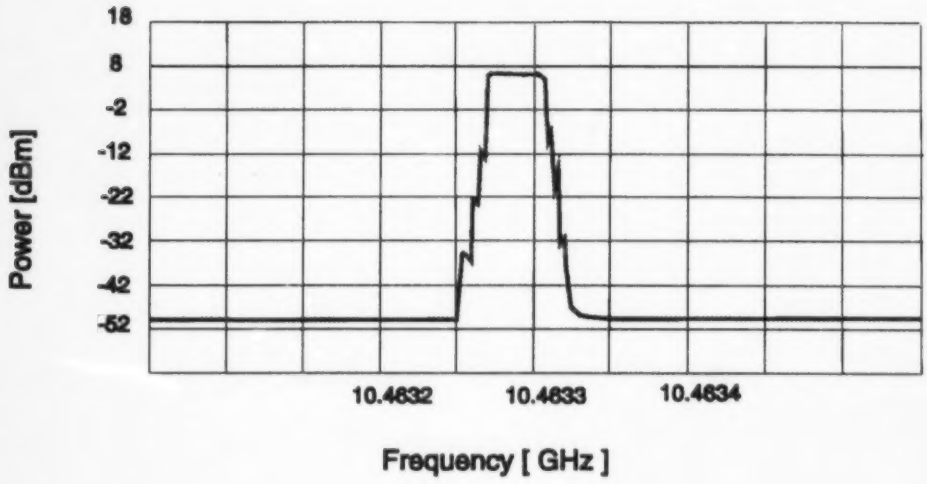

Figure 31: LO 30 sec. Drift when AN/SLR-503 set at 10.0 GHz

a frequency counter, it does provide a graphical representation which is more intuitive. These figures indicate that the LO exhibits a drift between 50 and 100 kHz. This fact alone means that using the AN/SLR-503 as a tuner for an intrapulse system would preclude that system from making instantaneous frequency measurements to an accuracy better than $\pm$ 100 kHz. Indeed the situation would be worse than that because this is only in respect to the LO instability. The reason for the difference between those measurements and those performed with the frequency counter is that some large frequency drifts are more infrequent and momentary.

8.0 CONCLUSIONS

This report evaluated the AN/SLR-503 with respect to its usefulness as a tuner for an intrapulse system. Since it was found that the only way this could be done was to tap a portion of its 400 MHz IF signal, we examined different aspects of the quality of this signal.

The first aspect examined was the bandwidth of the 400 MHz IF signal for different settings of the LO frequency. We found that the bandwidth was not always symmetrical with respect to the 400 MHz IF and that the amplitude within the passband was not flat with an exceptionally bad case exhibiting a 30 dB variation over 100 MHz.

We also examined the phase distortion introduced by the AN/SLR-503. Although absolute measurements could not be obtained, a method to make relative measurements showed that the peak group delay variations were at least as high as 12.5 nsec. at certain frequencies within a 100 MHz passband. This means that a nonstationary signal with a frequency change of 2.4 MHz over 0.1 μsec. would experience an instantaneous frequency error ot 300 kHz. It was to be expected that the phase corruption be fairly high since this is related to the smoothness of the amplitude of the passband which was shown to be inadequate.

Finally, we evaluated the frequency converter accuracy of the AN/SLR-503 which is dependent on the quality of the LO. We first noted that there was a mistuning between the display and the LO which could be as high as 220 MHz and a tuning knob sensitivity that varied between 1 and 5 MHz. These two factors affect the accuracy of the frequency measurements. We also noted that the LO drifts on the order of 100 kHz with momentary drifts as high as 1000 kHz. It is important to note that the errors caused by the poor quality of the LO are not included in the previous measurements and is therefore an additional compounding factor.

Therefore, from the measurements that were performed, it is clear that the AN/SLR-503 should not be used as the tuner for an intrapulse system.

ACKNOWLEDGEMENTS

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[1] Department of National Defence, Ottawa, Ontario, Canada, *Handbook for Countermeasures Receiving Set AN/SLR-503 (C-58-180-000/MS-000)*, Sept. 1976.

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